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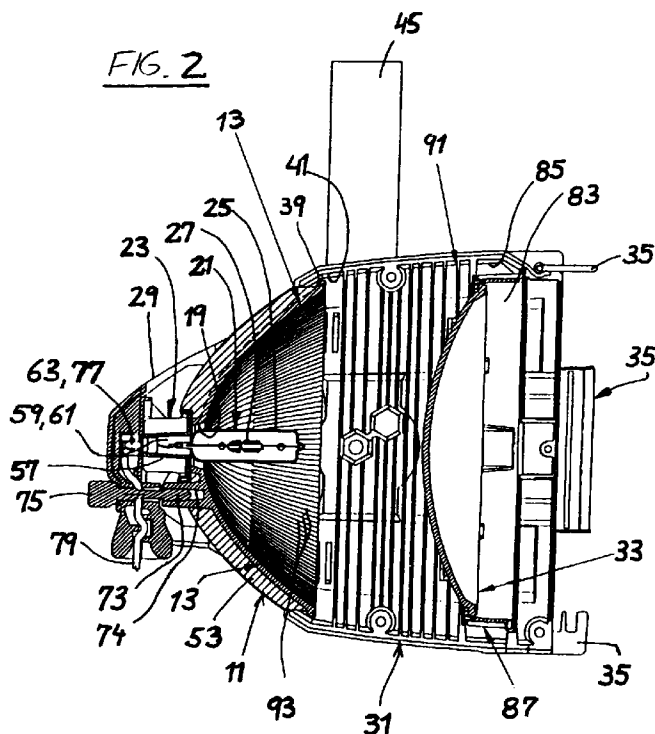
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(54) Lighting fixture having a cast reflector

(57) Disclosed is a lighting fixture for projecting a beam of light useful in theater, television, and architectural lighting applications. The fixture includes cast substrate comprised of a heat-conductive material, with a concave front side that defines a reflective surface and a convex rear side that defines a plurality of cooling fins exposed to the fixtures's exterior, to provide enhanced convective cooling. This configuration enables the use

of special temperature-sensitive reflective coatings that otherwise would be subject to degradation. A receptacle is defined in the cast reflector substrate, for conformably receiving the cast base of a lamp assembly, thereby enabling a precise positioning of the lamp assembly's filaments in a prescribed position relative to the reflective surface without the need for manual adjustment.



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Description

BACKGROUND OF THE INVENTION

This invention relates generally to lighting fixtures and, more particularly, to lighting fixtures specifically configured to project a beam of light used in theater, television and architectural lighting applications.

Lighting fixtures of this particular kind typically include a symmetrical, concave reflector and a lamp assembly having one or more light sources (e.g., filaments) located at or near a focal region of the reflector. The lamp assembly usually is removable from the reflector, but sometimes is integrated with the reflector to form a single unit. The reflector and lamp assembly typically are carried within a closed rear housing, which serves as the lighting fixture's main structural member. In some instances, a tubular front housing, which carries a projection lens, is secured to the front end of the rear housing, adjacent to the concave reflector's mouth. A gel frame retainer is carried at the front end of the front housing, for retaining a removable gel frame that colors the projected beam.

Some lighting fixtures of this kind are configured to image the projected beam of light at a distant location, e.g., a theater stage. In such fixtures, the concave reflector is generally ellipsoidal and the lamp assembly is positioned with its one or more filaments located generally at or near one of the reflector's two focal regions. A gate assembly is carried by the front housing, at the location of the reflector's second focal region, and this gate assembly includes, for example, a removable pattern and/or a plurality of shutters for shaping the projected beam. In operation, light emitted by the filaments is reflected to the gate assembly, and the projection lens then images the aperture of the gate assembly at the selected location.

Other, non-imaging lighting fixtures of this kind have concave reflectors configured generally as paraboloids, and the lamp assembly is positioned with its one or more filaments located generally at or near the reflector's single focal region. In operation, light emitted by the filaments is reflected forwardly to produce a beam of selected beamwidth.

In both imaging and non-imaging lighting fixtures of this kind, the position of the lamp assembly relative to the concave reflector is often made to be adjustable. This adjustability enables the assembly's one or more filaments to be selectively positioned at or near the reflector's focal region, such that the projected beam's energy distribution can be optimized.

As mentioned above, the lighting fixture's rear housing, which carries the concave reflector and lamp assembly, serves as the fixture's main structural element. A U-shaped support bracket for attaching the fixture to an overhead support typically is secured to this rear housing. Special means also are included within the rear housing for supporting the reflector.

The lighting fixtures described briefly above have

functioned generally satisfactorily in projecting beams of light for use in theater, television, and architectural lighting applications. However, the fixtures are believed to have included an excessive number of components and, therefore, to have been unduly complex and costly. In addition, the reflectors of such fixtures are believed to have been unduly susceptible to overheating, which can be problematic when there is a desire to use certain temperature-sensitive coatings. It should, therefore, be appreciated that a need exists for a lighting fixture of this general kind that is less susceptible to overheating and that is less complex in construction, yet that provides at least comparable performance in projecting beams of light having a desired, optimal energy distribution. The present invention fulfills this need.

SUMMARY OF THE INVENTION

The present invention is embodied in a lighting fixture for theater, television, and architectural applications, that is particularly effective in dissipating excess heat and that is substantially less complex in construction and less costly than prior fixtures of this kind, yet that provides at least comparable performance in projecting beams of light having a desired, optimal energy distribution. More particularly, the lighting fixture includes a cast substrate having a concave, substantially symmetrical surface defining an optical axis (e.g., a paraboloid or an ellipsoid), an opposite, convex surface that defines a plurality of cooling fins exposed to the lighting fixture's exterior, and a receptacle of predetermined shape and size, in alignment with the optical axis. A reflective coating is located on the substrate's concave surface, and a lamp assembly is included, having a glass envelope and one or more light sources (e.g., filaments or arcs) located within the envelope, and further having a cast lamp base with a predetermined peripheral shape and size configured to fit conformably in the receptacle of the cast substrate. The lamp assembly is configured with its one or more light sources located in predetermined, fixed locations relative to the cast lamp base, such that when the assembly is mounted to the cast substrate with its cast lamp base conformably received in the substrate's receptacle, the light sources are located in predetermined, fixed positions relative to the substrate.

This conformable positioning of the cast lamp base in the receptacle of the cast substrate eliminates the need for a lamp mounting means that allows selective adjustment of the lamp's light sources relative to the reflector. In addition, integrating cooling fins directly into the reflector substrate's convex side, and directly exposing those fins to the fixture's exterior, makes the fixture substantially simpler in construction, and therefore less costly, and also makes the fixture substantially less susceptible to overheating problems, thereby facilitating the use of certain desirable reflective coatings that otherwise would be subject to damage. The cast substrate preferably is formed of a highly heat conductive material

such as aluminum.

Other features and advantages of the present invention should become apparent from the following description of the preferred embodiment, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a lighting fixture embodying the invention, suitable for use in theater, television, and architectural lighting applications.

FIG. 2 is a side cross-sectional view of the lighting fixture of FIG. 1.

FIG. 3 is an exploded rear perspective view of the cast reflector, lamp assembly, and burner assembly of the lighting fixture of FIG. 1.

FIG. 4 is a rear elevational view of the lighting fixture of FIG. 1.

FIG. 5 is a front elevational view of the lighting fixture of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the drawings, for purposes of illustration, and particularly to FIGS. 1-3, there is shown a lighting fixture for projecting a high-intensity beam of light useful in theater, television, and architectural lighting applications. The fixture includes a reflector 11 having a reflective surface 13 in the general shape of a paraboloid, which defines an optical axis 15 and which has a general focal region. A receptacle 17 is defined on the rear side of the reflector, with a central aperture 19 aligned with the optical axis, for receiving a lamp assembly 21. The lamp assembly includes a base 23, an elongated glass envelope 25 secured to the base, and a plurality of filaments 27 located within the envelope. The lamp base is configured to fit conformably within the receptacle 17, with a longitudinal axis of the elongated glass envelope aligned with the reflector's optical axis 15 and with the filaments located at or near the focal region of the reflective surface 13. A burner assembly 29 secures the lamp assembly in place and delivers electrical power to the lamp assembly.

Light emitted by the filaments 27 of the lamp assembly 21 is reflected by the reflective surface 13 of the reflector 11 forwardly past the reflector's circular mouth, to produce a beam that is centered along the optical axis 15. A two-part, generally tubular front housing 31 is secured to the reflector's circular mouth, with its longitudinal axis aligned with the optical axis. This front housing carries a lens 33 that spreads the projected beam and further carries at its forward end a set of brackets 35 that functions as a retainer for a colored gel frame (not shown) that colors the projected beam.

The front housing 31 includes left and right halves 31a and 31b, respectively, which are assembled together by bolts 37. This two-part construction allows

the front housing to be conveniently assembled to the reflector 11, with an annular flange 39 at the reflector's mouth matingly received within an annular channel 41 at the front housing's rearward end. Decorative arms 43a and 43b project rearwardly from the respective left and right halves, toward the burner assembly 29. A conventional U-shaped support bracket 45 is secured by bolts 47a and 47b to the front housing's respective left and right halves. A bolt 49 with an enlarged, hand-graspable head 51 is used to tighten the support bracket in any desired orientation, so as to controllably direct the beam of light.

The reflector 11 and the front housing 31 both are cast of aluminum or other suitable thermally conductive material (e.g., zinc). This construction provides the components with sufficient strength to constitute the lighting fixture's main structural components. The need for a separate housing for the reflector thereby is eliminated. The reflector's rear, convex side, therefore, can be exposed to the ambient air, which significantly improves convective cooling of the fixture. To this end, the reflector's rear side is configured to include a plurality of parallel cooling fins 53. Moreover, because the fins are an integral part of the reflector 11, the transfer of heat is further enhanced.

Like the reflector 11, the base 23 of the lamp assembly 21 is cast of aluminum or other suitable material (e.g., ceramic), and it includes a plurality of parallel cooling fins 55. These fins project in opposite directions from a central, generally rectangular center body 57. The upper surface of the base's center body has a generally rectangular recess 59 sized to receive the lower end of the lamp assembly's glass envelope 25. The envelope is fixed in place using a suitable potting compound 61 (FIG. 2). Power leads 63 extend from the glass envelope downwardly through apertures in the base, to project from the base's lower surface.

The base 23 of the lamp assembly 21 is configured to have a size and shape that conformably mates with the receptacle 17 of the cast reflector 11. In particular, the fins 55 of the base define a generally cylindrical outer shape, with flats 65 defined on two opposed sides of the cylinder. Two ribs 67 extend longitudinally along each flat. The reflector's receptacle 17 is formed by cut-outs in the five centermost cooling fins 53 on the reflector's rear side, which form a generally cylindrical recess. A generally ring-shaped seat 69 encircles the receptacle's aperture 19, to receive the base's flat upper surface. Slots 71 formed in two of the reflector's cooling fins are sized and positioned to receive the ribs 67 that extend along the two flats 65 of the base, thereby preventing rotation of the lamp assembly about the fixture's optical axis 15.

Because the reflector 11 and the base 23 of the lamp assembly 21 both are cast, their shapes and sizes are substantially invariant and the position of the lamp base relative to the reflector, therefore, can be known with reasonable accuracy. This feature is important in enabling the fixture to project a beam of light having the

desired spread angle and the desired intensity distribution without requiring the positioning of the lamp assembly relative to the reflector to be controllably adjustable.

Critical in the projection of a beam of light having the desired spread angle and the desired intensity distribution is the positioning of the lamp filaments 27 relative to the reflector's parabolic, reflective surface 13 and, in particular, relative to the general focal region of that surface. It is, therefore, important that the filaments be precisely positioned relative to the lamp base 23. This is accomplished during manufacture of the lamp assembly 21 by first securing the filaments within the glass envelope 25, at an imprecise, but fixed position, and by then controllably positioning the lower end of the glass envelope within the base recess 59 such that the filaments are precisely positioned relative to the base. The glass envelope then is fixed in that precise position using the potting compound 61. In this manner, placement of the lamp assembly in the receptacle 17 of the reflector 11 will automatically position the filaments 27 at the desired position relative to the reflector's parabolic, reflective surface 13.

After the lamp assembly 21 has been placed within the receptacle 17 of the cast reflector 11, it is secured in place by the burner assembly 29. The burner assembly, itself, is secured to the rear side of the reflector by a single screw 73 that is configured to engage a threaded bore 74 machined in the reflector, adjacent to the receptacle. The screw has an enlarged, knurled head 75, to facilitate its convenient tightening by hand. The burner assembly includes an electrical connector 77 engageable with the two leads 63 that project downwardly from the lamp assembly. Electrical power is delivered to the connector, and thereby to the lamp assembly, by a power cord 79.

Various coatings can be used to form the parabolic, reflective surface 13 of the cast reflector 11. In one form, the surface is first polished and then coated with an aluminum coating using a vapor-deposition process. An overcoat of silicon oxide or suitable polymer then is applied over the aluminum coating, to protect the coating from abrasion, etc. In an alternative form, the polishing step is substituted by a step of coating the parabolic surface with a specular undercoat. Suitable materials for this specular undercoat include a high-temperature polymer such as a catalyzed silicone thermoset resin. In both cases, the reflective aluminum coating is made to be sufficiently uniform to provide a well defined beam of light.

The vapor-deposited aluminum coating can comprise high-purity aluminum, which generally has a reflectivity of about 89%. Alternatively, the vapor-deposited aluminum coating can comprise an enhanced coating that includes an aluminum layer overlaid by an alternating stack of silicon oxide and metal (e.g., titanium or tantalum) oxide layers. These alternating layers each have a thickness that approximates one-quarter wavelength at a particular nominal wavelength of interest. This enhanced coating can provide a reflectivity on

the order of 95%.

When a specular undercoat of the kind described above is used, care must be taken to ensure that its temperature does not exceed a threshold that typically is in the range of about 200 to 300 degrees Centigrade. If this temperature threshold is exceeded, the undercoat can degrade. Avoiding an excessive temperature also is an important consideration when a protective polymer overcoat is used. The reflector's integral fins 53, the positioning of those fins on the fixture's exterior, where convection can more easily carry away excess heat, and the casting of the reflector 11 of aluminum, which is highly conductive of heat, greatly facilitates the maintenance of the temperature of the specular undercoat, or the protective polymer overcoat, below this temperature threshold.

In yet another form, the parabolic surface of the cast reflector 11 is coated with a coating system that is dichroic, reflecting substantially all of the incident visible light, but absorbing substantially all of the incident infrared light. Such a reflector commonly is called a cold mirror. This coating system includes an undercoat formed of a material that is highly absorptive of infrared light, such as a vapor-deposited metallic coating, and an overlaying coating formed of a large number of alternating layers of silicon oxide and metal (e.g., titanium or tantalum) oxide, which transmits infrared light, but reflects visible light. Those skilled in the art will know of numerous alternative suitable materials for use in this coating system.

In the dichroic coating system, the absorptive undercoat can sometimes be subject to degradation over time at high temperatures. It is therefore desirable to maintain the temperature of this material as low as possible, and preferably below about 300 degrees Centigrade. The direct contact between the undercoat and the underlying aluminum reflector 11, together with the reflector's integral fins 53 and the positioning of those fins on the fixture's exterior, where convection can more easily carry away excess heat, greatly facilitates the maintenance of the temperature of this undercoat below the target maximum temperature.

The lens 33 functions principally to spread the projected beam of light and thereby provide the desired beamwidth. Several different lens configurations can be used, including a tempered clear glass lens and standard PAR 56 diffusion lenses, available in different degrees of spread from various manufacturers. The PAR 56 diffusion lenses include an array of rectangular lenslets 81 (FIG. 5), each of which functions to spread incident light by a predetermined amount. Some PAR 56 lenses provide a diffusion pattern that generally is circumferentially asymmetric, so the lens is made to be controllably rotatable within the front housing 31. To this end, the lens is carried within a plastic, ring-shaped lens holder 83, which is confined within an annular channel 85 (FIG. 2) defined in the front housing's inner wall. A plurality of ribs 87 located on the outer cylindrical surface of the lens holder are exposed through apertures

89 (FIG. 1) in the front housing, to allow a convenient manual rotation of the lens holder and lens.

A plurality of parallel baffles 91 (FIG. 2) project inwardly from the inner wall of the front housing 31, rearwardly of the annular channel 85 that receives the lens holder 83 and lens 33. These baffles reduce the intensity of light emitted in directions outside the desired beamwidth.

With reference to FIG. 2, the filaments 27 of the lamp assembly 21 preferably are in the form of a plurality of wire coils arranged in symmetrical pattern around the assembly's longitudinal axis. In addition, the reflective surface 13 of the reflector 11 preferably includes a plurality of radial facets 93, which serve to eliminate undesired filament images in the projected beam. The preferred lamp assembly and reflective surface are described more fully in U.S. Patent No. 5,268,613, which is incorporated by reference.

It should be appreciated from the foregoing description that the present invention provides an improved lighting fixture for theater, television, and architectural applications that is less susceptible to overheating and that is less costly and less complex in construction, yet that provides at least comparable performance in projecting beams of light having a desired, optimal energy distribution. This performance is achieved by constructing the fixture's reflector as a cast, structural component whose rear side defines a plurality of cooling fins exposed directly to the fixture's exterior and by constructing the fixture's lamp assembly to have a cast base that is conformably received in a receptacle formed in the cast reflector.

Although the invention has been described in detail with reference to the preferred embodiments, those skilled in the art will appreciate that various modifications can be made without departing from the invention. Accordingly, the invention is defined only by the following claims.

Claims

1. A lighting fixture comprising a lamp assembly (21) that includes a lamp having a glass envelope (25) and at least one light source (27) located within the glass envelope (25), and a lamp base (23) that supports the glass envelope (25) and the at least one light source (27), and a reflector (11) that includes a concave, substantially symmetrical front surface (13) defining an optical axis (15), characterized by a convex rear surface, opposite the concave front surface (13), defining a plurality of cooling fins (53) that form an exterior surface of the lighting fixture, and a receptacle (17) aligned with the optical axis (15) and having a predetermined peripheral shape and size, wherein the lamp assembly (21) is mounted to the reflector (11) with its lamp base (23) conformably positioned in the receptacle (17), such that the at least one light source (27) of the lamp assembly (21) is located in a predetermined, fixed position relative to the reflector (11).
2. A lighting fixture as defined in claim 1, characterized by a reflective coating located on the concave surface (13) of the reflector (11), preferably a cast substrate, wherein the reflective coating degrades at temperatures above a predetermined threshold, and wherein the reflective coating includes a specular undercoat.
3. A lighting fixture as defined in claim 2, wherein the reflective coating degrades at temperatures of about 300°C.
4. A lighting fixture as defined in claim 2 or 3, wherein the reflective coating further includes: a reflective metallic coating overlaying the specular undercoat; and a protective overcoat overlaying the metallic coating.
5. A lighting fixture as defined in claim 2, wherein the reflective coating further includes a dichroic coating that overlays the specular undercoat and transmits a substantial portion of any incident infrared radiation, but reflects a substantial portion of any incident visible light.
6. A lighting fixture as defined in claim 1, wherein the reflector (11) is a cast substrate comprised of aluminum.
7. A lighting fixture as defined in one of claims 1 to 6, further including a burner assembly (29) fixedly attachable to the rear surface of the lamp base (23) and having a receptacle (77) that releasably receives, and delivers electrical power to, the lamp assembly (21).
8. A lighting fixture as defined in one of claims 1 to 7, further including a cast lamp base (23) having cooling fins (55).
9. A lighting fixture as defined in claim 8, wherein the cooling fins (55) are mating with the cooling fins (53) of the reflector (11).
10. A lighting fixture as defined in claim 8 or 9, wherein the cast lamp base (23) is comprised of aluminum.
11. A lighting fixture for theater, television, and architectural applications, comprising:
 - a) a cast metal substrate (11) that includes a concave, substantially symmetrical surface (13) defining an optical axis (15) and further defining a substantially circular mouth, an exte-

rior surface, opposite the concave surface, defining a plurality of cooling fins (53) and forming an exterior surface of the lighting fixture, and a receptacle (17) aligned with the optical axis (15) and having a predetermined peripheral shape and size; 5

b) a reflective coating located on the concave surface (13) of the cast metal substrate, wherein the reflective coating degrades at temperatures above a predetermined threshold, and wherein the reflective coating includes a specular undercoat; 10

c) a generally cylindrical front housing (31) secured to, and projecting forwardly from, the mouth of the cast metal substrate; 15

d) a lens (33) carried within the front housing (31);

e) a gel frame retainer (35) carried by the front housing (31);

f) a lamp assembly (21) that includes a lamp having a glass envelope (25) and a source (27) located within the glass envelope (25), and a cast lamp base (23) that supports the glass envelope (25) and the light source (27) and that has a predetermined peripheral shape and size configured to fit conformably in the receptacle (17) of the cast metal substrate, wherein the lamp assembly (21) is configured such that its light source (27) is located in predetermined, fixed location relative to the cast lamp base (23); 20 25 30

g) a burner assembly (29) fixedly attachable to the exterior surface of the cast metal substrate (11) and having a receptacle (77) that releasably receives, and delivers electrical power to, the lamp assembly (21), 35

wherein the lamp assembly (21) is received by the cast metal substrate (11) with its cast lamp base (23) conformably positioned in the substrate's receptacle (17), such that the light source (27) is located in predetermined, fixed position relative to the substrate (11) and such that light emitted by the light source (27) is reflected by the reflective coating through the lens (33) to produce a beam that is projected away from the lighting fixture, along the optical axis (15). 40 45

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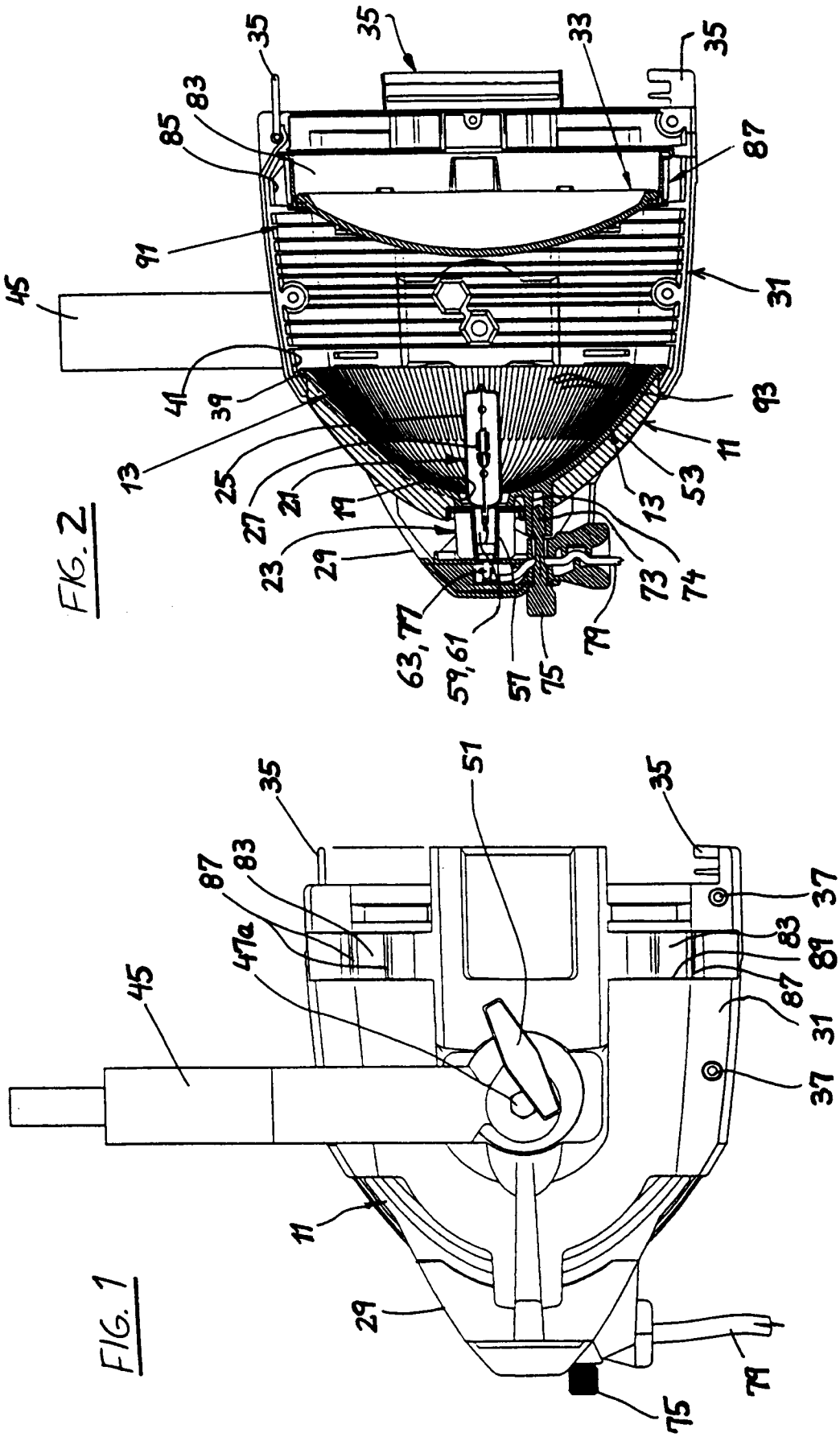


FIG. 3

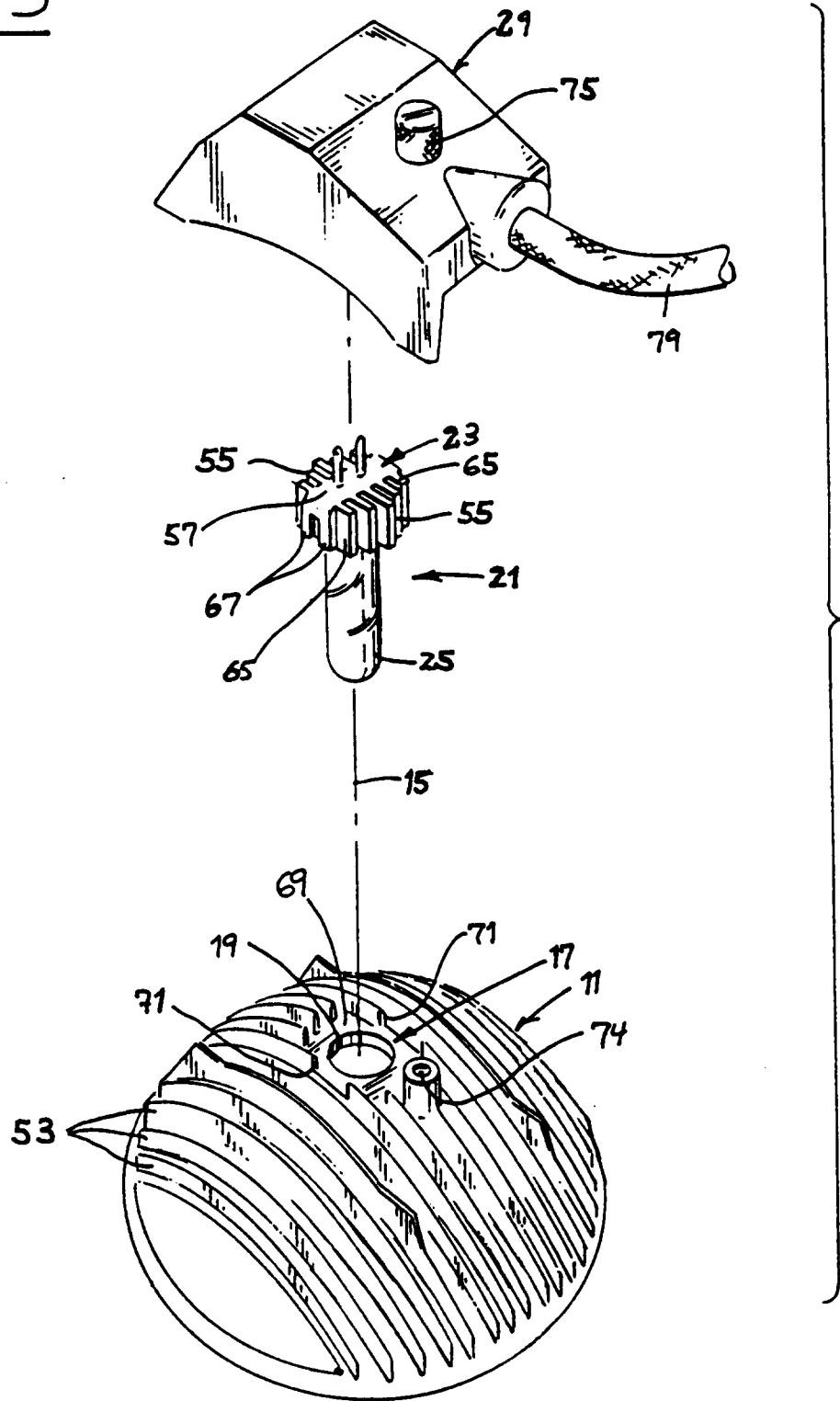


FIG. 4

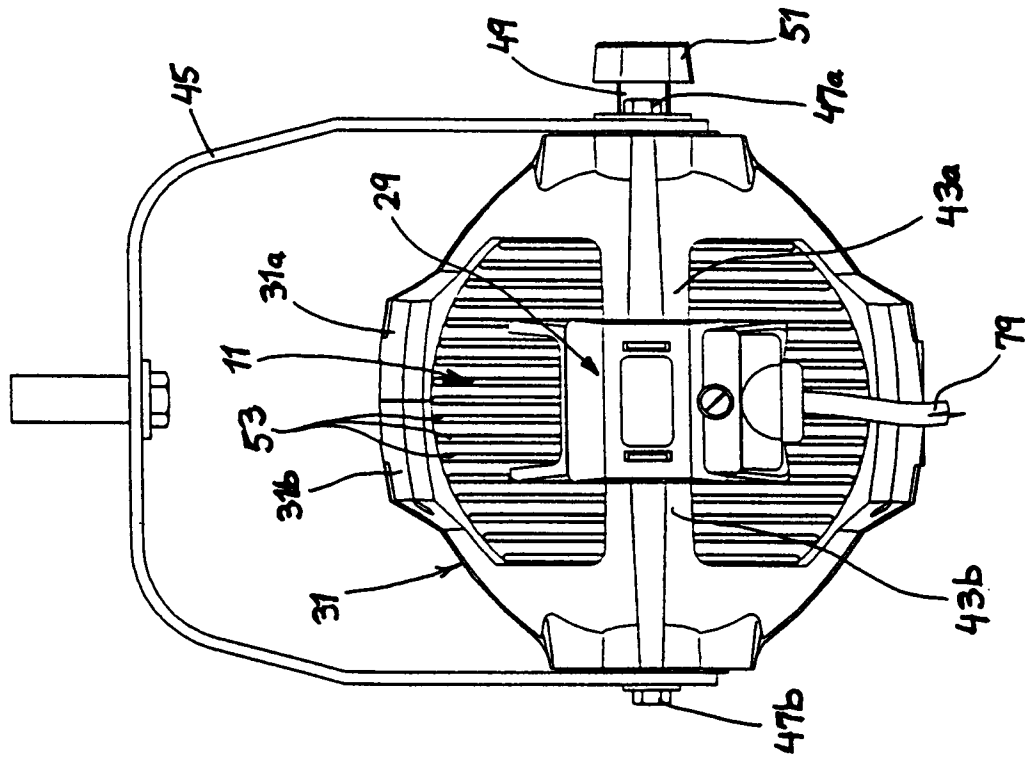


FIG. 5

